FLORIDA POLYTECHNIC UNIVERSITY

# Broader Impacts

## Potential Benefits & Risks to Society

**Alexander R. Murphy**

# What are Broader Impacts

## From The National Science Foundation (NSF)

### Inclusion

- Increasing and including the participation of women, persons with disabilities, and underrepresented minorities in STEM.

### STEM Education

- Improving education and educator development — at any level — in science, technology, engineering and mathematics.

### Public Engagement

- Increasing public scientific literacy and public engagement with STEM.

### Societal Well-Being

- Improving the well-being of individuals in society.

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# What are Broader Impacts cont.

## From The National Science Foundation (NSF)

### STEM Workforce

- Developing a more diverse, globally competitive STEM workforce.

### Partnerships

- Building partnerships between academia, industry, and others.

### National Security

- Improving national security.

### Economic Competitiveness

- Increasing the economic competitiveness of the U.S.

### Infrastructure

- Enhancing infrastructure for research and education.

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# NSF's Broad Categories

## Are They Sufficient?

Inclusion, STEM Education, Public Engagement, Societal Well-Being, STEM Workforce, Partnerships, National Security, Economic Competitiveness, Infrastructure

1. How are NSF's categories for broader impacts useful?

2. How might we improve them?

3. Are there any considerations that NSF leaves out?

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# NSF’s Broad Categories

## Are They Sufficient?

### 1. How are NSF’s categories for broader impacts useful?

They provide a structured framework for evaluating the societal and educational contributions of research, ensuring that projects consider diverse and meaningful benefits beyond scientific outcomes.

### 2. How might we improve them?

Expand the categories to include interdisciplinary collaboration and global impact, emphasizing the importance of international cooperation and cross-disciplinary integration in addressing global challenges.

### 3. Are there any considerations that NSF leaves out?

Yes, ethical considerations like data privacy and community engagement in research design are not explicitly addressed but are crucial for responsible and impactful research.

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# How to Evaluate Broader Impacts?

## NSF's Approach

1. What is the potential for the proposed activity to benefit society or advance desired societal outcomes?
2. To what extent do the proposed activities suggest and explore creative, original or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized and based on sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team or institution to conduct the proposed activities?
5. Are there adequate resources available to the principal investigator (either at the home institution or through collaborations) to carry out the proposed activities?

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# Beyond NSF's Definitions

## 1. Financial Impact

### Communities:

- Projects can influence local economies by creating jobs, increasing property values, or attracting investment.

### Shareholders:

- Innovations and technological advancements can affect company profitability, stock prices, and shareholder value.

### Local Businesses:

- Innovations and technological advancements can affect company profitability, stock prices, and shareholder value.

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# Beyond NSF's Definitions

## 2. Environmental Impact

### Sustainability:

- Consideration of long-term environmental effects, such as reducing carbon footprint or promoting renewable resources, can align design projects with global sustainability goals.

### Resource Use:

- Efficient use of natural resources in design and manufacturing can reduce environmental degradation and promote conservation.

### Biodiversity:

- Design and technology can either support or threaten biodiversity, making it essential to consider impacts on ecosystems and species.

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# Beyond NSF's Definitions

## 3. Ethical Impact

### Privacy and Data Security:

- Especially relevant in fields like data science and computer engineering, ensuring that technologies protect user privacy and comply with ethical standards.

### Social Justice:

- Projects can either mitigate or exacerbate social inequalities, making it essential to consider who benefits from or is disadvantaged by technological advancements.

### Accessibility:

- Design should consider the needs of all users, including those with disabilities, ensuring equitable access to technology and resources.

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# Beyond NSF's Definitions

## 4. Global Impact

### International Collaboration:

- Research and design can have implications that cross national boundaries, influencing global policies, and fostering international partnerships.

### Cultural Impact:

- Technologies and designs can shape cultural norms and practices, influencing how societies interact with technology.

### Technology Transfer:

- Innovations developed in one region can be shared globally, promoting development and addressing challenges in under-resourced areas.

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# Beyond NSF's Definitions

## 5. Market/Industry Impact

### Innovation and Competition:

- Advances can disrupt existing markets, create new industries, and drive economic competitiveness.

### Product Lifecycle:

- The design and manufacturing processes can impact the lifecycle of products, influencing waste management and recycling efforts.

### Supply Chain Effects:

- New designs and technologies can impact the entire supply chain, influencing everything from raw material sourcing to product distribution.

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# Broader Impacts in Capstone

## Integration into the Design Process

**Concept Phase**:

- Identify potential societal, environmental, and economic impacts early in the design process.

**Prototyping Phase**:

- Assess the feasibility and sustainability of the prototype, considering resource use and accessibility.

**Testing Phase**:

- Collect feedback from diverse stakeholders to understand possible unintended consequences.

**Final Design Phase**:

- Evaluate the comprehensive ethical implications, long-term societal impact, and potential for positive change.

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# Identifying Potential Impacts

## Knowns and Unknowns

*“…there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns — the ones we don’t know we don’t know.”*

*– Donald Rumsfeld*

https://medium.com/@andreamantovani/known-knowns-known-unknowns-unknown-unknowns-leadership-367f346b0953

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# Case Study 1

## Flint Water Crisis

https://time.com/4189116/flint-michigan-water-study-photo/

### Overview:

- The Flint Water Crisis began in 2014 when the city of Flint, Michigan, switched its water supply from treated Detroit water to the Flint River to cut costs. The new water source was not treated properly, causing lead from old pipes to leach into the water supply. As a result, thousands of residents were exposed to lead contamination.

### Broader Impacts:

- **Ethical:** Engineers and government officials failed to take public health and safety seriously, disregarding early warnings from residents and scientists about water quality.
- **Social Equity:** Flint is a predominantly low-income, minority community. The crisis highlighted the disparity in how different communities receive public services and resources, raising questions of environmental justice.
- **Regulatory Failure:** Authorities ignored established water treatment protocols and failed to comply with the Safe Drinking Water Act. This resulted in long-term health consequences, especially for children, leading to lawsuits and significant public outcry.
- **Lessons for Capstone:** Students can explore how infrastructure projects can have profound social and ethical consequences, particularly when public health is involved. In their own projects, students should consider stakeholder input, adhere to regulatory standards, and prioritize the welfare of all community members, particularly vulnerable populations.

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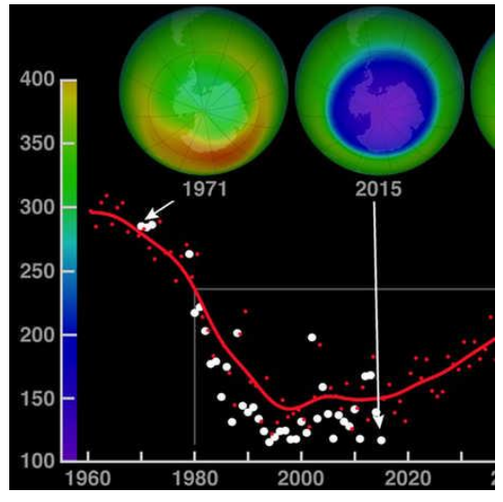
# Case Study 2

https://ozonewatch.gsfc.nasa.gov/




## CFC Ban and Ozone Layer Recovery

### Overview:

- Chlorofluorocarbons (CFCs) were once commonly used in refrigerants, air conditioning, and aerosol sprays. In the 1970s and 1980s, scientists discovered that CFCs were depleting the ozone layer, which protects the Earth from harmful ultraviolet (UV) radiation. This led to the 1987 Montreal Protocol, an international treaty that phased out the production and use of CFCs.

### Broader Impacts:

- **Sustainability**: The phase-out of CFCs is one of the greatest successes in environmental sustainability. The ozone layer has shown signs of recovery, demonstrating the effectiveness of global cooperation in addressing environmental issues.
- **Economic Impact**: The CFC ban required industries to develop alternative, environmentally-friendly refrigerants. While this imposed short-term economic costs on industries that relied on CFCs, the long-term benefits in terms of public health and environmental protection outweighed these costs.
- **Regulatory Success**: The Montreal Protocol is often cited as a model for international environmental cooperation and regulatory action. It highlights how effective regulations can drive innovation and sustainability in engineering and environmental sciences.
- **Lessons for Capstone**: Students can learn about the importance of environmental impact assessments in their projects. Sustainable design not only benefits the environment but can also drive innovation. International cooperation and adherence to environmental regulations are key in tackling global challenges.

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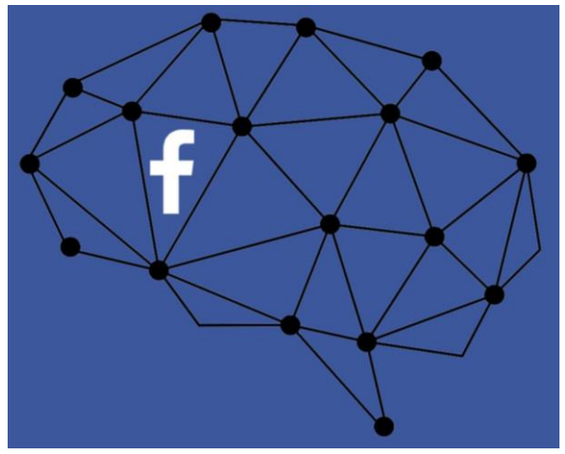
# Case Study 3



## Facebook-Cambridge Analytica Scandal

https://www.fastcompany.com/40554519/collateral-damage-from-facebooks-cambridge-analytica-scandal-keeps-getting-worse

**Overview**:

- In 2018, it was revealed that Cambridge Analytica, a political consulting firm, had harvested personal data from millions of Facebook users without their consent. The data was used to target political ads during the 2016 U.S. presidential election and the Brexit referendum. Facebook's failure to protect user data raised serious ethical and legal concerns.

**Broader Impacts**:

- **Ethical**: Facebook failed in its responsibility to safeguard users' personal data. The scandal exposed the dark side of data mining and targeted advertising, raising questions about privacy, consent, and the ethical use of technology.
- **Social Impact**: The misuse of personal data to influence elections had a profound social impact, fueling debates about democracy, privacy rights, and the role of social media in shaping public opinion.
- **Regulatory Impact**: The scandal led to increased scrutiny of tech companies and new regulations on data protection, such as the European Union's General Data Protection Regulation (GDPR). Facebook faced significant fines and reputational damage.
- **Lessons for Capstone**: Students working on software, cybersecurity, or data science projects must consider the ethical implications of their work, particularly concerning user privacy and data protection. Projects should include safeguards for user consent and data security to avoid social and legal consequences.

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